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HUMBOLDT BAY MUNICIPAL WATER DISTRICT GROUNDWATER MANAGEMENT PLAN

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1.0 INTRODUCTION

The Humboldt Bay Municipal Water District (HBMWD) received a Local Groundwater Management Assistance Act grant from the California Department of Water Resources to study the groundwater supplying the HBMWD system, and to create a Groundwater Management Plan (GWMP) for the Mad River Basin. The Groundwater Management Act, California Water Code, Part 2.75, §10753, also known as Assembly Bill 3030 (AB 3030), provides public agencies with the authority to prepare groundwater management plans. The intent of AB3030 is to promote cooperative management of groundwater resources by local agencies and stakeholders within groundwater basins. In recognition of the importance of the groundwater resources to the overall water supply needs of water users and land owners in the Mad River region, the District's Board of Directors authorized the preparation of a GWMP with Resolution 2005-3, which was passed at an advertised public hearing in March 2005.

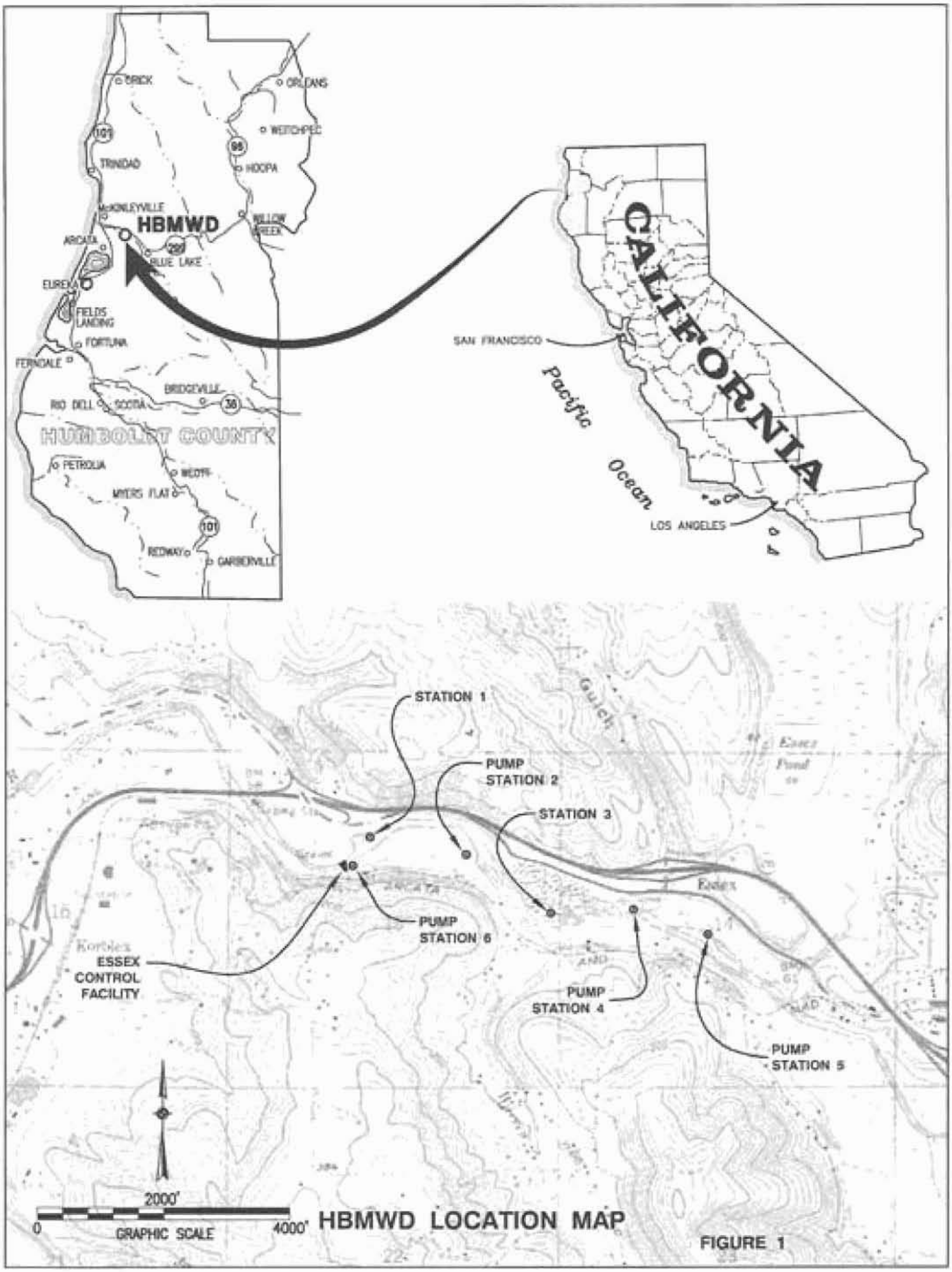
1.1 Groundwater Management Plan Scope

The scope of this GWMP addresses groundwater management issues impacting groundwater extraction in the Lower Mad River Area, in particular, the groundwater basin used by HBMWD. A large portion of Humboldt County's population uses groundwater from the Mad River Basin, mainly through HBMWD's system. This GWMP addresses specific issues as requested by AB 3030 as well as other issues relevant to the area. To address this groundwater management issues and develop management strategies, this document:

- Gives a brief background of the District
- States the goals of the GWMP
- Characterizes the Mad River Basin and Sub-basins sub-surface hydrology
- Presents a basin map
- Discusses a conceptual hydrogeologic model
- Discusses a numerical groundwater model
- Summarizes the groundwater management issues required by law and assesses the relevance to the Mad River Basin
- Presents five groundwater management strategies

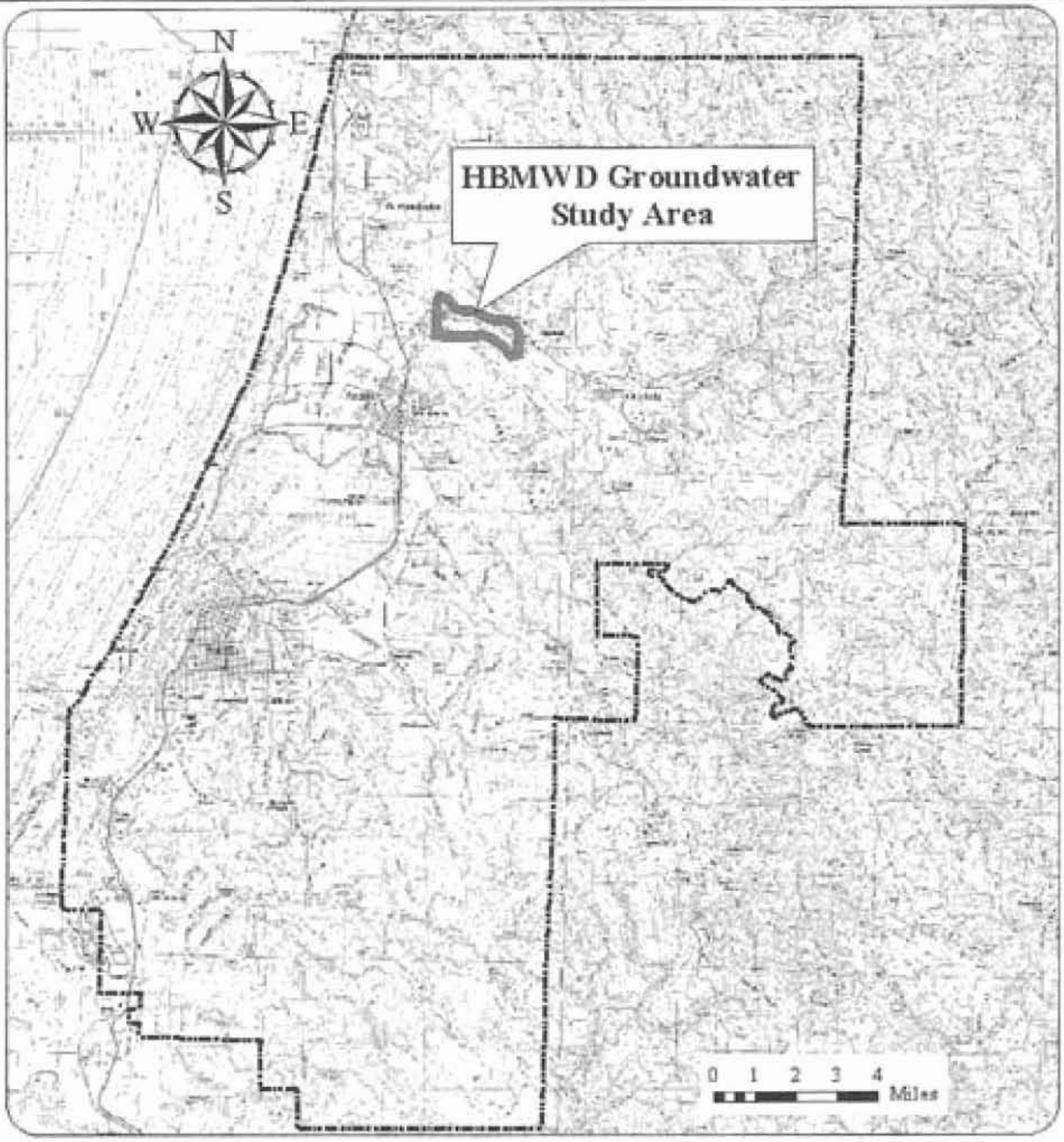
1.2 District Background

Humboldt Bay Municipal Water District produces water from four Ranney wells located near the District's Essex Control Center on the Mad River in Arcata. The location of HBMWD Essex Control Center facility and the Ranney wells are shown in Figure 1. The active Ranney wells are labeled Pump Stations 1 through 4. Also shown are Pump station 5 and 6. Pump Station 5 is a mothballed Ranney well that is not is production and Pump Station 6 is a raw water surface diversion. Up to 21 million gallons per day (MGD) is pumped from the Holocene River Deposits that underlie the Mad River channel. The HBMWD facilities provide water to the communities of McKinleyville, Arcata, Eureka, Manila, Blue Lake, Fieldbrook, Cutten, Samoa, Fairhaven, and the Humboldt Community Service District. The District was established in 1956 to provide domestic and industrial water for the area and includes the most heavily populated and developed parts of the county. Based on data for the Census tract making up the District's service area (shown in Figure 2), the 2000 population of the District was approximately 75,911 or 60% of the population of Humboldt County. The projected population growth for the county has been estimated at 0.4% annually through the year 2030, which would yield a District population of 85,569 in 2030.



HBMWD LOCATION MAP

FIGURE 1



Map of Humboldt Bay
Municipal Water District Boundary

Legend

District Boundary

Groundwater Study Area

Figure 2

1.3 Authority

The Groundwater Management Act, allows any local public agency which provides water service to all or a portion of its service area and whose service area includes all or a portion of a groundwater basin to adopt programs to manage groundwater. The law contains 12 components which may be included in a groundwater management plan. Each component may play some role in evaluating or operating a groundwater basin so that groundwater may be managed to maximize the total water supply while protecting the groundwater quality.

Having passed the Resolution to develop a Groundwater Management Plan, the District is authorized to adopt rules and regulations to implement and enforce the Groundwater Management Program.

2.0 GROUNDWATER BASIN PLAN OBJECTIVE AND GOALS

The HBMWD provides potable water for domestic and business use, through seven municipalities, to approximately 60% of the population in Humboldt County. The District also supplies untreated raw water to local industrial customers. The objective of this Groundwater Management Plan is to provide a plan for ensuring a reliable, long term, cost efficient, high quality water supply for HBMWD customers and other water users in the area. Additional inherent objectives of preventing inelastic land surface subsidence and minimizing changes in surface water flow and quality are obtained through mandated releases from Matthews Dam (see Section 4.1.8). To accomplish this objective the District intends to evaluate and implement programs which will meet the following goals:

- Improve understanding of basin hydrology
- Understand interactions between Ranney collectors and influence of pumping on turbidity
- Preserve and enhance the reliability of groundwater resources of the area.
- Ensure the long-term availability of high quality groundwater

3.0 MAD RIVER GROUNDWATER BASIN

The Mad River Groundwater Basin is located in the North Coast Hydrologic Region of California in Humboldt County. The Mad River Groundwater Basin is the principal groundwater basin in the Eureka area and consists of two sub-basins, Mad River Lowland (1-8.01) and Dows Prairie (1-8.02), as defined by the Department of Water Resources.

3.1 Climate

Humboldt County has moderate temperatures and considerable precipitation. Temperatures along the coast in July are usually in the 60's and vary only 10 degrees from summer to winter, although a greater range is found over inland areas. Temperatures of 32 degrees or lower are experienced nearly every winter throughout the area, and colder temperatures are common in the interior. Maximum readings for the year often do not exceed 80 on the coast, while 100 degree plus readings occur frequently in the mountain valleys.

Rainfall is commonly experienced each month of the year, although amounts are negligible from June through August. About 90 percent of the seasonal total rainfall falls in the seven months from October through April. Most of this is associated with storm fronts that move in from the Pacific Ocean. There are few thunder showers in the mountains during the summer, but they are not frequent. Seasonal totals average about 40 inches near Eureka, and exceed 100 inches in the zones of heavy precipitation. Rainfall in Trinity County, where the District operates the R.W. Matthews Dam, averages 70 inches of rainfall per year. The average relative humidity is high due to large amounts of moisture and moderate temperatures. Due to the proximity of the Pacific Ocean, the coastal area has a cool, stable temperature regime. The marine influence is less pronounced as distance from the ocean increases, and inland areas experience wider variations of temperature and lower humidity.

3.2 Basin Hydrology

3.2.1 Mad River Lowland Sub-basin Hydrology (1-8.01)

The Mad River Lowland Sub-basin includes the coastal floodplain from the Freshwater Fault north to the Mad River and the elevated terrace areas to the east, as shown in Figure 3. The basin is bounded by Arcata Bay to the south, the Mad River to the north, and mountains to the east, as shown in Figure 3. The basin also includes Blue Lake Valley to the east. Between Mad River and Arcata Bay, the coastal plain is dissected by flood stage channels of the Mad River that are 15- to 20-feet deep. The Mad River discharges to the ocean approximately 5 miles north of Arcata Bay and is tidal for about 1 mile inland (DWR 2003).

The Mad River Groundwater Basin in the Blue Lake Valley and in the Mad River floodplain is composed of alluvium and is underlain by the Hookton Formation. Sand dunes are present along the coastline edge of the basin. The upland areas to the north and east are above the alluvium of the river floodplain and are comprised solely of the Hookton Formation. The entire basin area is underlain by bedrock. Seawater intrusion has occurred in the shallow aquifers near the ocean and bay areas. However, seawater is not present to any appreciable extent landward of the coastline (DWR 2003).

3.2.1.1 Geology

There are 5 identified water bearing units in the Mad River Lowland Sub-basin. The aerial extent of each hydrologic unit is shown on the Mad River Basin Map in Figure 3. A summary of these formations is found in Table 1.

Holocene Dune Sand

The Holocene Dune Sand is a marine shoreline and aeolian deposit formation and is shown in orange in Figure 3, and identified with the label "Qd". It consists of gravel and sand deposits on terraces, beaches, and dunes along current shorelines. Holocene Dune Sand represents an unconfined aquifer of unconsolidated materials recharged by rainfall, ocean, and locally by river underflow. Saltwater in this aquifer underlies freshwater due to slightly increased density of salt water. Disruption of this density difference by groundwater pumping may affect aquifer water quality. This aquifer is used locally in basin # 1-8.01 for minor agricultural operations drawing groundwater from shallow wells.

Holocene River Channel Deposits
The Holocene River Channel Deposits consists of clay, silt, sand, gravel and boulders deposited in stream beds terraces, flood plains, ponds, and soils formed on these deposits. It is shown in yellow in Figure 3 and identified with the "RC" label. This aquifer unit produces water of excellent quality and yield. It includes alluvial river channel deposits in excess of 100 feet in thickness, which constitutes the aquifer tapped by the HBMWD Ranney wells. Recharge to the unconfined Holocene River Channel Deposit aquifer is primarily from rivers (in channel areas) with recharge from rainfall in the Arcata Bottoms, and Arcata areas. The river channel deposits of the Mad River at Essex provide the main potable water supply for Eureka, Arcata, Blue Lake, McKinleyville, and surrounding communities.

Holocene Alluvium
Holocene Alluvium consists of clay, silt, sand, gravel and boulders in stream beds, terraces, flood plains, and ponds, and soils formed on these deposits exclusive of river channel deposits. It is shown in blue in Figure 3 and identified with the "Qal" label. Recharge to the unconfined Holocene alluvium aquifer is primarily from rainfall in the Arcata Bottoms, Arcata, Sunnybrae, and Bayside areas. The Holocene alluvium aquifer supplies groundwater primarily to agricultural wells.

Pleistocene Terrace deposits
Pleistocene Terrace Deposits consists of undifferentiated non-marine terrace dissected deposits and also typically include uplifted deposits of gravel, sand, silt, and clay deposited in fluvial settings. It is represented in pink and with the "Pt" label on Figure 3. It includes the marine terrace deposit of the Hookton Formation. Recharge to Pleistocene Terrace deposit unconfined aquifers is primarily by rainfall. Perched aquifers in the Pleistocene terrace deposits supply well water to some residences and agricultural operations. These aquifers may contribute flow to fluvial systems via springs.

Pleistocene Hookton Formation
The Pleistocene Hookton Formation is a marine terrace deposit typically uplifted, and consists of clay, sand, and some gravel deposited in nearshore marine (beach) settings. It is represented in red with a "Ph" label in Figure 3. The Hookton Formation is thought to underlie much of the surficial alluvium and soil between Arcata Bay and the Mad River. This formation is exposed in the hills north of Essex and in Blue Lake. The Hookton Formation supplies groundwater to wells serving residences and agricultural operations. Recharge to Hookton Formation unconfined aquifers is primarily by rainfall.

3.2.2 Mad River Dows Prairie Sub-basin Hydrology(1-8.02)

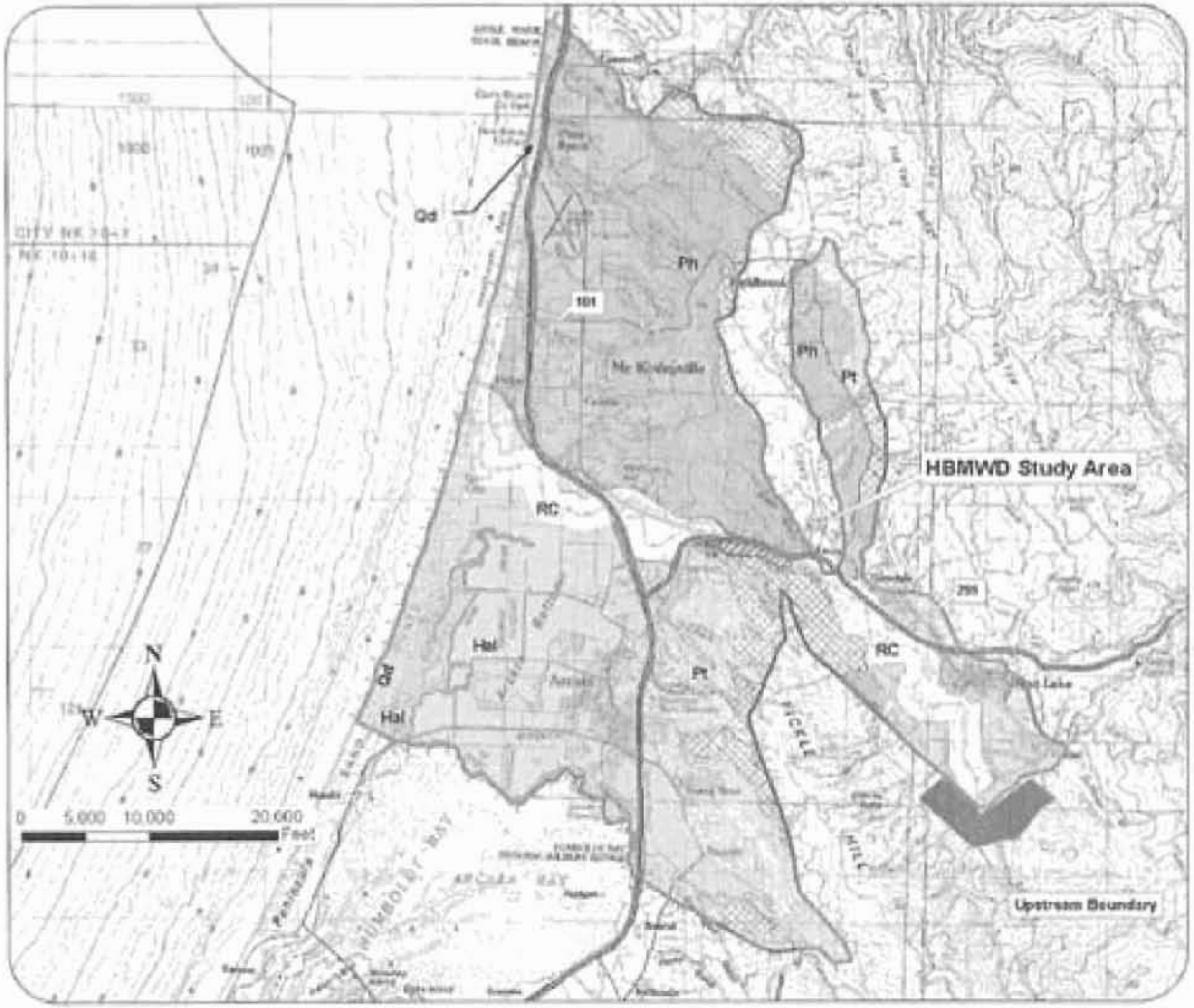
The Dows Prairie Sub-basin is located on the coast north of the Mad River Lowland Sub-basin and is bounded by Little River to the north and Mad River to the south, as shown if Figure 3. The sub-basin is bounded to the east by bedrock outcroppings. The sub-basin is part of an elevated terrace drained by several small creeks. Development of groundwater is primarily in the western portion of the sub-basin. The Hookton Formation is the main geologic unit in the area. The Franciscan Formation underlies the Hookton Formation and is essentially a non-water-bearing unit. (DWR 2003)

3.2.2.1 Geology

There is only one water bearing unit identified in the Dows Prairie Sub-basin. The aerial extent of this hydrologic unit is shown on the Mad River Basin Map in Figure 3.

Pleistocene Hookton Formation

The Pleistocene Hookton Formation was described in the previous section but it extends into the Dows Prairie sub-basin. The Hookton Formation is mapped by Evenson as occupying most of the area encompassed by basin # 1-8.02. The Hookton Formation supplies groundwater to a very few low yield wells serving residences and agriculture. Recharge to Hookton Formation unconfined aquifers is primarily by rainfall.



MAD RIVER GROUNDWATR BASIN:
MAD RIVER LOWLANDS SUB-BASIN AND DOWS PRAIRIE SUB-BASIN

Legend

Figure 3. Mad River Groundwater Basin

Table 1. Summary of Hydrologic Units of Mad River Basin

Formation	Recharge Area	Production	Quality/Yield
Holocene Dune Sand	Local Precipitation	Domestic shallow wells	Variable
Holocene River Channel	Mad River	Municipal	Excellent
Holocene Alluvium	Mad River and Precipitation	Municipal and Domestic	Excellent
Pleistocene Terrace	Perched Water	Domestic wells	Variable
Pleistocene Hookton Formation 1-8.01	Upland Precipitation	Domestic wells	Fair
Pleistocene Hookton Formation 1-8.02	Precipitation	Domestic wells	Fair

3.2.3 Areas of the Mad River Basin Included in the Groundwater Management Plan

Based on the Authority, as outlined in Ssection 1.3 of this report, this GWMP seeks to focus the extent of management issues to areas related to the production of potable water by the HBMWD. While the GWMP evaluates and inventories the entire Mad River Basin, the management issues addressed in this GWMP are applicable only to hydrologic units and areas that are influenced by the operations of, or under the control of the HBMWD. The HBMWD study area includes the Holocene River Deposit from the upstream boundary where the Mad River crosses the basin boundary at the highest elevation to just below the Essex Control Center Facility. The study area is shown in Figure 3.

In areas outside of the GWMP study area, traditional water right, environmental, and water quality regulations apply. For traditional water rights, overlying landowners have a right to extract as much groundwater as they can put to beneficial use, and they do not need a water right permit from the State Water Resources Control Board. However, in regions such as California where water is scarce, groundwater supply may be insufficient to fully supply the requirements of all land owners. In these cases, the available supply must be equitably apportioned, and groundwater use is subject to management in accordance with court decrees adjudicating the groundwater rights within the basins. At this point there has been no adjudication of groundwater within the Mad River basin.

3.2.4 Groundwater Modeling

Effective management of groundwater systems requires a comprehensive knowledge of hydrologic processes, and effects of environmental conditions on water quality and quantity.

To evaluate these processes and conditions, a groundwater model was developed for the study area. The groundwater model was used as a management tool to assess existing and future conditions. Management scenarios included evaluation of: Impacts on the water table near the Ranney wells due to pumping drawdown, down stream impacts on the Mad River due to pumping, determining maximum pumping rates from the system while maintaining water quality, and assessing the impacts of the interactions between production wells with respect to water quality, mainly turbidity.

In addition to simulating various groundwater management scenarios, the model results were used to evaluate impacts on the system. Model results were easily managed through a GIS interface which allowed for model result viewing and interpolation in conjunction with real time data.

As with any computer model, the results of a groundwater model are only as good as the information they use. Site and system information was compiled in a site conceptual model. Developing a detailed site conceptual model is essential to creating an accurate model. A detailed site conceptual model was created by spatially relating data from: site reconnaissance and investigations, field measurements, geophysics and geological assessment, and analysis of monitoring data. This information was then transformed to numerically represent the system. The model simulates the processes within the groundwater system to predict conditions, such as groundwater heads and velocity fields.

The construction of the site conceptual model for the Mad River basin near the Ranney wells was started based on an initial site investigation. This investigation included the evaluation of existing river, pumping, and water quality data, interviews with current system operators, the gathering climatic and flow data, and the analysis of aerial photos and maps.

The subsurface bedrock boundaries and site hydrologic conditions were defined based on geologic and geophysical investigations, including a seismic refraction study, and the installation of four new soil borings (groundwater monitoring wells). Data from the boring well logs for the new and existing soil borings was used to characterize the subsurface hydrogeology. Soil borings within the study area near the Ranney wells were converted to monitoring wells which are continually used to calibrate and validate the model.

To ensure meaningful results and predictive capability, a MODFLOW-based hydrologic modeling system, MODFLOW-SURFACT, was used. MODFLOW-SURFACT combines fully integrated hydrologic water quality subsurface flow and transport capabilities with GIS capabilities under a graphical user interface. MODFLOW-SURFACT was specifically designed to accurately simulate the interactions between surface and groundwater systems and achieve mass conservative results where simpler computer codes fail to produce mass conservative results.

MODFLOW uses the block-centered finite-difference approach to simulate groundwater flow. Fully or quasi 3-D simulations of confined and unconfined layers may be performed. MODFLOW-SURFACT provides an option for discretizing the domain using an axisymmetric geometry for efficient simulation of pumping tests, baildown/recovery tests, etc. External stresses normally allowed by MODFLOW include constant head, constant flux, areal recharge, evapotranspiration, drains, and streams. In addition, the model provides a rigorous well withdrawal package, unconfined recharge boundary conditions, and seepage face boundary conditions. MODFLOW-SURFACT contains additional capabilities which include rigorous saturated-unsaturated moisture movement simulation capability, air flow simulation capability, and a Newton-Raphson linearization package for improved robustness. These capabilities improve the model accuracy for simulating the groundwater system near the Ranney wells because of the rapid hydraulic response in gravels and pumping rates from the Ranney wells.

4.0 GROUNDWATER MANAGEMENT PLAN ISSUES

The Groundwater Management Act outlines twelve specific components or issues that should be addressed in a groundwater management plan. Groundwater management plans developed with these components empower local agencies to adopt programs to manage groundwater. This groundwater management plan used the 12 recommended components as a guide for development. In this section of the GWMP each required groundwater management issue is described and the relevance to the Mad River Basin is assessed. The groundwater management issues that are addressed as recommended by AB3030 are:

- Control of saline water intrusion
- Identify and management of wellhead protection areas and recharge areas
- Regulation of the mitigation of contaminated groundwater
- Identification of well construction policies
- Administration of well abandonment and well destruction program
- Construction and operation of groundwater projects by the local agency including: groundwater cleanup, recharge, storage, conservation, water recycling, and extraction
- Review of land use plans and coordination with land use planning agencies to assess activities which create a reasonable risk of groundwater contamination
- Mitigation of conditions of overdraft
- Replenishment of groundwater extracted by water producers
- Monitoring groundwater levels and storage
- Facilitating conjunctive use operations
- Development of relationships with state and federal agencies

Additional issues not listed under AB3030 which are also considered in this Groundwater Management Plan are:

- Meeting the current and future drinking water quality standards
- Meeting the current and future drinking water demands

4.1 Groundwater Management Plan Issues Required by AB3030

In this section, the groundwater management issues identified in the previous section are discussed. Many of these issues have overlapping management actions as many of the issues are physically interrelated. A summary of the issues and associated management actions may be found in Table 2 at the end of this section.

4.1.1 Saline Water Intrusion

The control of saline water intrusion is directly related to maintaining groundwater quality. The possible causes of saline intrusion include:

- increase in salt content dissolved from earth material
- lateral or upward migration of saline water
- downward seepage of sewage
- agricultural or industrial waste
- downward migration of mineralized surface water
- inter-aquifer migration of saline water
- sea water intrusion.

In the case of HBMWD groundwater production, saline intrusion does not pose a significant threat to water quality. This is due to the location of the extraction wells with respect to saline water sources and the properties of the hydrologic unit. The extraction wells are located approximately 6 miles from the coast in the Holocene River Channel Deposits, far from the salt water lens. The recharge to the Holocene River Channel Deposits is relatively quick and is controlled by maintaining the Mad River levels via releases from Matthews Dam. Therefore, saline intrusion is not a threat to the HBMWD extraction wells.

4.1.2 Wellhead Protection

Wellhead protection entails the identification and management of wellhead and recharge areas. Typically the protection areas would include a groundwater travel time assessment and an evaluation of areas, that could allow contamination to reach the production wells within a given time period.

The existing HBMWD groundwater extraction wells are located in or near the Mad River primary channel and groundwater is extracted from the underlying river channel sediments Because of the rapid groundwater recharge rates of the Holocene River Deposit near the HBMWD extraction wells, the travel time approach for determining wellhead protection areas is not practical. The recharge areas are near the well head and may extend up the river channel. Therefore, the region that includes all areas within in the influence of the extraction wells are considered for wellhead protection.

Threats to wellhead and recharge areas come from two potential sources. The first is physical activities that may alter the channel, and the second is contaminants entering the recharge water. Activities pertaining to the alteration of the stream bed that may adversely impact water quality, wildlife, or habitat are regulated by Regional Water Quality Control Board (RWQCB), California Department of Fish and Game (DFG), and the Army Corp of Engineers. Possible contamination of the potable water produced by District is addressed by California Department of Health Services, Department of Toxic Substances Control, and RWQCB regulations. Therefore, threats to well head and recharge areas are already controlled by existing agencies.

4.1.3 Mitigation of Contaminated Groundwater

The downward migration or contaminants from sewage, agricultural, or industrial waste is a potential source of groundwater contamination. However, as with wellhead protection, current local, state, and federal regulation restrict activities that could threaten the groundwater quality near the area of influence of the HBMWD extraction wells.

Threats to groundwater quality are regularly assessed by monitoring the water quality in the Mad River, which recharges the Holocene River Deposits. If a leak or a spill is identified, effective control and clean-up would be conducted by the appropriate parties. This would include coordinated efforts with the regulatory agencies involved, source control and containment, and contamination delineation. Regulatory agencies may include California Department of Health Services (DHS), RWQCB, DFG, Army Corp of Engineers, Department of Toxic Substances Control, EPA, and HBMWD. The level of involvement of each agency would depend upon the nature and extent of the threat.

4.1.4 Well Construction Policies

Well construction and abandonment are listed as separate items by the DWR, but in practicality they pose similar threats to groundwater and are governed by the same regulations. Therefore, they are considered together in this GWMP.

Improperly constructed or abandoned wells can adversely impact groundwater quality by creating a vertical conduit for the migration of contamination from the surface to groundwater or between groundwater units. All wells drilled in the Mad River Basin are regulated by the Humboldt County Environmental Health Department. Installation of wells must conform to the California Water Code §13700 through §13806 and must be installed by contactors with an active C-57 Contractor's license. In addition, a County drilling permit must be attained. A minimum standard for the construction and demolition of wells is specified in DWR Bulletins 74-81 and 74-90. Therefore, the threat from improperly constructed or abandoned wells is very small.

4.1.5 Well Abandonment Policies

Well abandonment policies are addressed in the previous section.

4.1.6 Construction of Groundwater Projects

Part of the GWMP is to evaluate the impact of the construction and operation of projects pertaining to groundwater quality and quantity within the groundwater basin. These projects include: groundwater contamination cleanup (covered in Section 4.1.3), groundwater storage, groundwater recharge, groundwater extraction, water conservation, and water recycling. These items re discussed further below.

4.1.6.1 Groundwater storage, recharge, and extraction

The storage, recharge, and extraction of groundwater at HBMWD facilities are closely related. The groundwater extracted by HBMWD is solely from the Holocene River Deposits. The recharge to the River Channel Deposits is primarily from the Mad River and is a function of the river stage or level.

The District operates Matthews Dam which impounds water in Ruth Lake. The District manages releases from the dam to insure sufficient groundwater recharge conditions throughout the year. The District currently has appropriative water rights to store water at Ruth Lake and divert 75 million gallons a day (MGD) from the Mad River at the Essex facility. This is approximately 8% of the total average Mad River Basin runoff.

Recharge to the Holocene River Deposits and any possible subsequent interactions with other hydrologic units is achieved through releases from Matthews Dam and by maintaining sufficient flows for the protection, propagation, and preservation of fish and wildlife.

4.1.6.2 Water Conservation Projects

Water conservation is an approach to reduce potable water demands, and is an essential component for basins that have water deficits. To mitigate the water deficits, conservation measures such as low flow toilets and fixtures, water saving clothes washers, and restrictions on outdoor irrigation may be implemented. The District currently has sufficient capacity to meet demands, thus mandatory conservation measures are unnecessary. Additionally, implementing conservation measures would be completely voluntary, as the District has no legal authority to implement such measures.

4.1.6.3 Water Recycling

Water recycling is another approach to reduce potable water demand. Recycled water requires a high degree of treatment and a parallel delivery system. Due to the sufficiency of current and water supplies a water recycling project is not warranted at this time.

The HBMWD is a regional water wholesaler and does not operate or have any authority over wastewater collection and treatment in the area.

4.1.7 Impact of Land Use Plans

The rapid recharge rates of the Holocene River Channel Deposits heighten the threat to groundwater posed by potential degradation of water quality in the Mad River caused by land use activities. Issues relating to these threats are primarily addressed by Humboldt County Community Development Service Department, Land Use Planning Department. Land use that may potentially impact the recharge areas are addressed through zoning ordinance and compliance. In addition, activities that may impact the Mad River are regulated by RWQCB, California Department of Fish and Game, Army Corp of Engineers, and EPA. The District regularly reviews plans and works in coordination with Humboldt County Community Development Service Department, Land Use Planning, to assess activities which may create a threat groundwater quality or quantity.

4.1.8 Mitigation of Overdraft Conditions

Overdraft of groundwater occurs when more groundwater is extracted from the basin than is returned. This can cause land subsidence, decreased water quality, and declining groundwater level. As stated in the section on storage, recharge, and extraction, the recharge to the Holocene River Channel Deposits is managed by maintaining water levels in the Mad River. Therefore, the risks of overdraft are curtailed by balancing flows in the Mad River with groundwater extraction.

While the recharge to the Holocene River Deposits in the area of the HBMWD's wells is met by the balanced flows in the Mad River, the Mad River may also serve to recharge other hydrologic units within the basin. The interaction between the river and these units is complex and will vary with location. In some locations the river may gain water from the adjacent hydrologic units and in others it may recharge them. Regardless of the type of interaction, the minimum recharge or drainage conditions are satisfied by maintaining the flows required by the terms of the Domestic Water Supply Permit. Any actions that would impact the groundwater interactions between the river, river deposits, and adjacent hydrologic units would require a permit from DWR.

4.1.9 Replenishment of Extracted Groundwater

The replenishment of extracted groundwater entails returning water to the groundwater basin either through natural recharge or other anthropogenic means. This issue is addressed in the Storage, Recharge, and Extraction, and Mitigation of Overdraft sections.

4.1.10 Monitoring of Groundwater Production, Levels, Storage, and Water Quality

HBMWD produces water from four Ranney wells at the District's Essex Control Center just northeast of Arcata. Water is pumped from the Holocene River Deposits that underlie the Mad River channel. The Ranney wells withdraw water from approximately 60-90 feet deep.

HBMWD currently records the production and water levels from their wells and operations at the Essex facility. Additionally, water quality is constantly monitored and water quality samples are regularly taken. Water quality samples are sent to a certified analytical laboratory for assessment.

4.1.11 Facilitating Conjunctive Use Operations

Conjunctive use of water refers to the use of water resources where groundwater and surface water interface and influence each other. Rainfall, evaporation, runoff, percolation, and transpiration combine to influence the water available at a specific location at a particular point in time. The hydrologic cycle controls water available for use. The speed at which water moves among stages in the hydrologic cycle and the amount of time it spends in storage at any stage affects water availability to users.

Typically, this refers to the practice of storing excess surface water in groundwater during wet periods for use during dry period. In the Mad River Basin the amount of storage in hydrologic units is limited by the local soil conditions. Thus, conjunctive use in the Mad River Basin refers to the storage of surface water during wet periods and using surface water to control recharge to groundwater during dry periods.

The HBMWD conjunctive use of water is addressed in the storage, recharge, and extraction section. Any incidental conjunctive use between other hydrologic units is addressed by maintaining the required flows for fish and wildlife. Any other groundwater exactions that may be considered as conjunctive use would require a permit from DWR.

4.1.12 Develop Relationship with Regulatory Agencies

The District maintains a positive working relationship with the regulatory agencies. Early participation of agencies and stakeholders will provide the opportunity to include their concerns in the GWMP.

5.0 GROUNDWATER MANAGEMENT STRATEGIES

In this section of the GWMP, five groundwater management strategies are identified described. A groundwater management strategy is a general approach to actions that address one or more of the management issues listed in Section 4. The Mad River Basin GWMP proposes five Groundwater Management Strategies to address the groundwater management issues listed in Section 4. The groundwater management issues addressed by each management strategy are shown in Table 2. The specific Groundwater Management Strategies are described below and include:

1. Groundwater, wellhead, and recharge area protection by adhering to existing permits, regulations, and laws.
2. Monitoring of the groundwater quality in the region of the Ranney wells.
3. Maintaining groundwater recharge by the operation of Matthews Dam and Ruth reservoir.
4. Groundwater modeling and studies.
5. Stakeholder involvement.

5.1 Groundwater Protection Through Existing Regulations and Permit Requirements

A management strategy for groundwater protection is to comply with existing regulations that relate to new construction or activities within the river channel. These regulatory requirements cover new construction activities and existing permit requirements.

The water quality of the Mad River and activities in the river channel, where groundwater recharge occurs, may have a direct impact on groundwater quantity and quality. Activities that have the possibility to impact the river, river channel, or groundwater are covered by existing regulations. These types of activities are regulated by several agencies, such as: RWQCB, Department of Fish and Game, Army Corp of Engineers.

Additionally, as a requirement of the Districts Domestic Water Supply Permit that is issued by DHS, Division of Drinking Water & Environmental Management, the District has performed and maintains a source water assessment as part of the Drinking Water Source Assessment and Protection Program. The assessment identifies the location of the drinking water source, delineates the source area and protection zones, establishes a physical barrier effectiveness checklist, inventories the possible contaminating activities (PCAs), ranks the PCAs based on vulnerability, establishes an assessment map, and creates an assessment summary.

5.2 Groundwater Monitoring Protocol

The District has monitored groundwater conditions for over 45 years. As a management strategy, the District will continue to monitor and analyze groundwater conditions near Essex groundwater production facilities. In accordance with the DHS Domestic Water Supply Permit and because it is the goal of the District to supply reliable high quality potable water, the District continuously monitors groundwater production (elevations and water quality) at the Essex facility. Additionally, water quality samples are sent to a certified analytical laboratory for testing and assessment as part of the DHS mandated Annual Chemical Monitoring Schedule in accordance with state and federal drinking water regulations. The following daily operational performance monitoring including groundwater monitoring is done:

- temperature, turbidity, and groundwater levels are continuously monitored through the SCADA system,
- particle counts are performed daily,
- bacteriological (Total Coliform & e. Coli) analysis are performed monthly, and
- total trihalomethanes and haloacetic acids (TTHM/HAA5), giardia, cryptosporidium, and nitrate analysis are performed at least yearly.

5.3 Operation of Matthews Dam and Ruth Lake

As a management strategy to address groundwater recharge, mitigation of potential overdraft, conjunctive use, and long term supply, the District operates Matthews Dam and Ruth Lake. Groundwater recharge is achieved by the inundation of the recharge areas in the Mad River channel.

During high-discharge periods the District does not control the amount of water released because water flows freely over the spillway structure. This only occurs when the elevation of Ruth Lake reaches 2654 feet. In this case the natural flow from the river may satisfy the demand requirement.

However, during the summer and fall low-flow periods, the District releases a sufficient amount of water from storage to meet its downstream demand requirement and its bypass flow requirement below Essex. If the District's demand for water increases (due to municipal growth or a new industrial customer) the amount of water released from storage would be increased to meet the new demand requirement.

The current withdrawal rate at the District's Essex diversion is approximately 25 to 30 MGD (28,000 to 34,000 acre-feet per year), which is only 3% of the total average runoff of the Mad River watershed. In prior years, the entire 75-MGD safe yield has been under contract, and up to 67 MGD has been withdrawn. A withdrawal rate of 75 MGD, (84,000 acre-feet per year) equates to approximately 8 percent of the total average annual runoff of the Mad River watershed.

5.4 Groundwater Modeling and Subsurface Studies

In an effort to better understand the subsurface hydrology and interactions between the Ranney Collectors the District will use a groundwater model and subsurface studies. The groundwater model is used as a management tool to assess actual or speculative scenarios under various conditions such as: impacts on the water table near the Ranney wells due to pumping drawdown, determining maximum pumping rates from the system while maintaining water quality, and assessing the impacts of the interactions between production wells with respect to water quality. In addition to simulating various groundwater management scenarios, the model results may be used in communicating impacts on the system due to various management scenarios.

5.5 Stakeholder and Interagency Involvement Protocol

Stakeholder and interagency involvement is essential to a successful GWMP. As primarily a water wholesaler the Districts neighboring agencies are also customers. The protocol for interagency corporation and public and stakeholder involvement involves multiple levels. The HBMWD has a publicly elected Board and holds regular meetings that are open to the public. Public announcements about the proposed development of a GWMP have been made and the proposed GWMP has been discussed at several meetings. As a water wholesaler, the District also holds regular meetings with its seven municipal customers where the GWMP has been presented and discussed.

Table 2. Management Strategies and Issues

Management	Strategy					
Issue	Mandated by AB3030	Ground-water Protection	Ground-water Monitoring	Matthews Dam Operation	Ground-water Modeling	Stakeholder Involvement
Saline Intrusion	Yes		X		X	
Wellhead & Recharge Area Protection	Yes	X	X			X
Mitigation of Contamination	Yes	X	X		X	X
Well Construction Policy	Yes	X				
Well Abandonment Policy	Yes	X				
Construction Projects	Yes	X			X	X
Land Use Coordination	Yes	X			X	X
Mitigation of Overdraft	Yes	X	X	X	X	X
Groundwater Recharge & Replenishment	Yes	X	X	X	X	X
Monitoring Groundwater Levels & Storage	Yes		X	X		
Conjunctive Use	Yes	X		X		
Agency Relationship	Yes	X	X	X	X	X
Water Quality	No	X	X	X	X	X
Water Demands	No	X	X	X	X	X

6.0 SUMMARY

The Mad River Basin Groundwater Management Plan was developed by the HBMWD to support their efforts at providing a reliable, long term, cost efficient, high quality water supply for the community. The District is a wholesale water producer that currently provides treated potable water for domestic and business use, through seven municipalities, to approximately 60% of the population in Humboldt County. The potable water produced by the District is drawn from the Holocene River Channel Deposits. These deposits underlie the Mad River in the river channel. The Mad River GWMP is therefore focused on, and limited to, the Holocene River Channel Deposits that may impact the Districts potable water production. The Mad River GWMP lists five groundwater management strategies to address the required and relevant groundwater management issues, as outlined in Section 4. The groundwater management strategies include: groundwater protection through existing regulations and permit requirements, continued groundwater monitoring, operation of Matthews Dam and Ruth Lake, groundwater modeling and studies, and stakeholder involvement.

REFERENCES:

Evenson, R. L. 1959, Geology and Ground-Water Features of the Eureka Area Humboldt County, California. Geological Survey Water-Supply Paper 1470

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California Department of Water Resources, 2003, California's Groundwater, Bulletin 118, Northcoast Hydrologic Region, Mad River Lowland Groundwater Basin.